Laboratory according to Mr. Stevenson's design, and tenders are to be obtained as early as possible.

Mr. J. W. L. Glaisher, F.R.S., is to be Additional Examiner in Part III. of the Mathematical Tripos in January, 1886.

Prof. Bonney and Mr. J. J. H. Teall are appointed Examiners for the Sedgwick Prize to be adjudged next year.

Prof. Macalister will take a class in Osteology during the Long Vacation. There will also be an Introductory Practical Course in Anatomy, illustrated by that of the Dog, superintended by the Professor and Mr. Rolleston. The Demonstrator will take a practical class in Histology during the Long Vacation.

SCIENTIFIC SERIALS

Journal of Anatomy and Physiology, vol. xix., Part 3, April 1, contains:—On the development of the blood-corpuscles in the embryo of *Perca fluviatilis*, by K. F. Wenckebach (plate 11).—Movements of the ulna in rotation of the fore-arm, by Dr. J Heiberg.—The nature of ligaments, part iii., by J. B. Sutton (plate 12).—Supernumerary cervico-dorsal vertebra-bearing ribs, with vertebral and costal asymmetry; abnormal articulation in a sternum, by W. A. Lane.—Some points in the histology of the medulla oblongata, pons varolii, and cerebellum, by Dr. W. A. Hollis (plate 13).—The external auditory meatus in the child; the relations of the larynx and trachea to the vertebral column in the fœtus and child; a rare abnormality of the pancreas, by Dr. J. Symington (plate 14).—The existence of a fourth species of the genus Balænoptera, by Dr. G. A. Guldberg.—Some variations in the anatomy of the human liver.—Notes on some unusual variations in human anatomy, by Dr. A. Thomson.—Observations in reference to bilateral asymmetry of form and function, by Dr. F. Tuckerman.—Case of exostosis of the ulna, by Dr. R. J. Anderson.—The mu culus sternalis and its occurrence in (human) Anencephalous monsters, by Dr. F. J. Shepherd (plate 15).—The venous system of the bladder and its surroundings, by E. H. Fenwick (plate 16).

The Journal of Physiology, vol. v., Nos. 4, 5, 6, contains:—Observations of the gastric glands of the pig, by M. Greenwood.—Hæmatin compounds, by V. D. Harris.—Papaïn digestion, by S. H. C. Martin.—The secretion of oxalic acid in the dog under a varying diet, by T. W. Mills.—On the comparison of the concentrations of solutions of different strength of the same absorbing substance, by S. Lea.—On the mutual antagonism between lime and potash salts in toxic doses, by S. Ringer.—The behaviour of the red blood corpuscles, when shaken with indifferent substances, by S. J. Meltzer and W. H. Welch.—On the cardiac rhythm of Invertebrata, by W. B. Ransom.—Some experiments on the liver ferment, by Florence Eves.—An experimental investigation showing that Veratria is similar to lime salts in many respects as regards their action on the ventricle; also showing that veratria and lime salts are reciprocally antagonistic, by S. Ringer.—Some observations on the influence of the vagus and accelerators on the heart of the turtle, by T W. Mills.—On the anatomy of the cardiac nerves in certain cold-blooded vertebrates, by W. H. Gaskell and Hans Gadow.

Vol. vi., Nos. 1 and 2.—Is the nervous impulse delayed in the motor nerve terminations? by A. W. Hoisholt.—Observations on some of the colouring matters of bile and urine, with special reference to their origin; and on an easy method of procuring hæmatin from blood, by C. A. MacMunn.—The edible bird's nest, or nest of the Java swift (*Callocalia nidifica*), by J. R. Green.—The velocity of accommodation, by J. W. Barrett.—On the physiology of the salivary secretion; part 3, the paralytic secretion of saliva, by J. N. Langley.

Gegenbaur's Morphologisches Jahrbuch, Bd. x., Heft 4, contains: On the morphology of nails, by C. Gegenbaur.—On direct nuclear division in the embryonal membranes in the scorpion, by F. Blochmann (plate 22).—On the derivation of the neural system in the nematodes, by O. Butschli (plate 23).—Studies on the developmental history of the cœloms and Cœlom-epithelial in the amphibia, by B. Solger (plates 24 and 25).—Some remarks on the true relations of organisation in the so-called cilioflagellates, and in the noctiluca, by O. Butschli; with a note by E. Askenasy (plates 26 to 28).—The foramen magendii, and the opening in the recessus laterales of the fourth ventricle, by C. Hess (plate 29).—Reply to Dr. Baur, by Dr. W. Dames.—On the beaks of birds and dinosaurs, by Dr. G. Baur.

Zeitschrift für Wissenschaftliche Zoologie, Band xli., Heft 3, contains:—On the history of the formation and on the morphological value of the ova of *Nepa cinerea* and *Notonecta glauca*, by W. Will (plates 20-22).—On the powers of transformation in the Mexican Axolotl, by Marie von Chauvin.—Contribution to a knowledge of the Trematodes, *Distomum palliatum*, nov. spec., and *D. reticulatum*, nov. spec., by A. Looss (plate 23).—The formation of the radula in the Cephalophorus Mollusca, by R. Rossler (plates 24 and 25).—Studies of the fauna of the larger and smaller ponds in the Riesengebirge, by O. Zacharias (plate 26).—On some common developmental processes in Vertebrates, by J. Kollman.

SOCIETIES AND ACADEMIES

London

Royal Society, April 23.—"The Essential Nature of the Colouring of Phytophagous Larvæ (and their pupæ); with an account of some Experiments upon the Relation between the Colour of such Larvæ and that of their Food-plants," by Edward B. Poulton, M.A., of Jesus and Keble Colleges, Oxford.

Abstract.

The Essential Nature of the Colouring of Phytophagous Larvæ.—Phytophagous larvæ are coloured by pigments derived from the food-plant, pigments proper to the larvæ, and tissues such as fat, which lend incidental aid to the colouring. The altered plant-pigments hitherto detected in larvæ are chlorophyll and xanthophyll, causing the colours green and yellow. The former is termed metachlorophyll, because of the difference between its spectrum and that of unaltered chlorophyll (in the leaf), and because of the chemical differences between its solution in larval blood, &c., and any known solution of plant chlorophyll. The evidence is at present insufficient to warrant the use of a separate name for the derived larval xanthophyll. Other colours hitherto examined are due to true pigments or tissues.

The following table indicates the situations occupied by the different causes of colour, and gives to some extent the historic order of their employment.

I. The internal tissues and organs with ready-made colour	*a*. Digestive tract. *b*. Fat. *c*. Dorsal vessel.
II. The passage of derived pigments through the walls of the digestive tract into	*a*. The blood. *b*. The subcuticular tissues.
III. The appearance of true pigment in	*a*. The hypodermis. *b*. The cuticle.

These causes explain larval and pupal colour, except such instances as the metallic tints of certain pupæ. The different stages of coloration mentioned in the table were not often mutually exclusive, but each new method was an additional resource. The derived pigments more often confer general resemblances, the true pigments special resemblances. In many cases the green colour is due to metachlorophyll in the blood only (many Noctuæ), while in other cases it is also placed in the subcuticular tissues (Sphingidæ). The former larvæ lose their colour locally on slight compression, while the swollen uncompressed part becomes of a deeper tint. When larvæ are dimorphic—green and brown—the colours of the former are mainly due to metachlorophyll, of the latter to true pigments. Such important differences in the causes of colour commonly occur among larvæ from the same batch of eggs, or in the life-history of a green larva, which becomes brown, or *vice versa*. The blood of brown larvæ, with transparent skins, is colourless except in very thick layers; in the brown *Chærocampa elpenor*, the blood becomes brown, but the bands of metachlorophyll and xanthophyll can be faintly seen. Hence these pigments are not destroyed beyond the point at which they cease to interfere with the changed colour. The derived pigments may exist unchanged in the blood after the larva has altered in colour, if the superficial pigments are completely opaque (many geometers). This persistence of the derived pigments may be very important to the organism. Thus the larva of *Ennomos angularia* is an opaque brown geometer, but pupates in a cocoon of loosely-attached leaves through which it can be seen. Before pupation the true pigment disappears, and the larva and pupa are coloured by metachlorophyll. Again, in many instances the derived pigments are retained in the blood of the pupa and segregated in the ova, when these are yellow or green, serving to tinge the newly-hatched larva before the effects of its first meal can become apparent. But after such a long period, and the alternation of solution in blood and deposition in tissue, the

colour of the more stable pigment—xanthophyll—preponderates over the green of the metachlorophyll in the newly-hatched larva. The bands of xanthophyll are distinctly seen in an alcoholic extract of crushed ova taken from the bodies of moths which have been preserved for ten years or longer. In blown and dried larvæ the greens soon fade, while the yellows persist and the pigment can be detected after many years. The true pigments are also unaltered. In larvæ preserved in spirit the derived pigments quickly disappear, and the alcohol is yellow with xanthophyll, while the true pigments are unchanged. These facts are also true of phytophagous hymenopterous larvæ, as well as in the lepidoptera. Thus in *Nematus curtispina* the green colour is due to derived pigment, while the broad white dorsal band is due to fat collected on each side of the dorsal vessel (and it can be seen to move with the pulsations of the latter). In *Cræsus Septentrionalis* fat becomes the vehicle for a yellow colour. The few exposed pupæ of moths are coloured in the same manner as the larvæ (*e.g.* the *Ephyridæ* and *E. angularia*). In the Ephyridæ, dimorphic larvæ—green and brown—produce pupæ which follow the colour of their respective larvæ. Larval markings can often be seen upon the pupa immediately after pupation. Thus the pupa of *Sphinx ligustri* is marked by the oblique stripes of the larva. The pupæ of butterflies are nearly always protectively coloured, and often possess the derived pigments. In *Papilio machaon* the derived pigments of the pupa are segregated in a very remarkable chitinised (?) subcuticular layer, which is quite opaque, so that no effect is produced by the bright yellow blood (xanthophyll).

Methods of Investigation and Spectra of derived Pigments.—Zeiss's micro-spectroscope was always employed, with bright sunlight as the means of illumination. The blood is obtained by pricking the pupa or the larva in some situation remote from the digestive tract. Existing under pressure, most of the blood at once emerges as a clear bright green or yellow liquid (when the derived pigments are present). It is received into a tube-section, with one end cemented to a glass slide, and when full a cover glass is placed upon the open end, becoming fixed by the drying of the blood. In most cases the blood so prepared will keep for months. The spectrum of metachlorophyll is as follows (in the case of the bright green fresh blood of the pupa of *Pygæra bucephalus* in a thickness of 23 mm.):—

Chief band in the red, 71°–65°, continuous with a less absorption extending to 58°, darkest from 58·5–59·5; a broad band from 52°–48° with the dimmed blue and violet coming through 48°–42°, from which latter point the violet end is absorbed. There is no absorption of the extreme red. A Zeiss's scale is adopted in which 1° = 1/100,000 mm.

Comparing this spectrum with that of true chlorophyll, as seen in two fresh calceolaria leaves, the whole spectrum is shifted towards the violet end in the latter case, with the exception of the end absorption, which extends to 43°. The chief band in the red is 70°–64·5, and then the continuous absorption of metachlorophyll is replaced by two bands: 61°–63° and 57·5–60°, and if anything the former is the darker. The broad band is 47·5–51°, and the dimmed blue and violet 47·5–43°. The chief difference is the continuity of the three bands of the red end in metachlorophyll, and the fact that their darkness is in the order (1) (3) (2) from the red, instead of (1) (2) (3). A similar spectrum (as far as it could be identified by the use of a paraffin lamp) was observed in a clear green fluid from the digestive tract of the larva of *Phlogophora meticulosa*. In yellowish green blood (pupa of *S. ligustri*) the absorption at the violet end is aided by the xanthophyll present, which gives two bands if the thickness of blood be sufficiently small. In some cases a third band is also present. Thus the blood of *S. ligustri* in a thickness of 3 mm. does not give the band of chlorophyll in the red, but shows three bands in the more refrangible half of the spectrum: 48°–50°, 45°–46·25, and 42°–43° the violet end being absorbed at 41°. Between these areas of absorption the spectrum is dimmed. The three bands become less distinct in the above-mentioned order, and the third can only be seen under favourable conditions of light, and appears to be absent in some cases. Mr. Sorby states that a third band, due to another substance, is sometimes present in the xanthophyll spectrum. While the spectrum of metachlorophyll is very constant over a large number of larvæ and pupæ, in the living green pupa of *Ephyra punctaria*, a form of chlorophyll with a rather different spectrum was met with, in which the second band of true chlorophyll is present instead of the continuous absorption, while the third band could not be seen in the slight thickness obtainable. The term "ephyra-chlorophyll" is given to this pigment, which is dissolved in the blood of the pupa. Metachlorophyll, and probably xanthophyll, are united with a proteid in the blood. The addition of ether to green blood brings down the combined pigment and proteid in the form of a green coagulum, from which the ether does not dissolve the metachlorophyll, but gradually takes up the xanthophyll, becoming bright yellow. Alcohol, on the other hand, decomposes the combined proteid and pigments, the coagulum rapidly becoming decolorised, and the xanthophyll passing at once into solution, while the metachlorophyll disappears. Hence it seems that the latter pigment depends upon its association with the proteid for its extreme stability and permanence under the action of light. This permanence is necessary for the larva, since any colour due to derived pigments implies the penetration of light, and often the complete translucence of the whole organism, and, further, there are long periods (at the ecdyses), during which the pigments cannot be renewed, because no food is taken. Then there are the extreme cases of the green Ephyra pupæ, and the green pupæ of *P. machaon*, freely exposed to daylight during two-thirds of the year. It seems certain that the derived pigments are merely protective, and are of no further importance in the physiology of these organisms. Thus it is not probable that there are any marked differences between the physiological processes of the green and brown larvæ from the same batch of eggs, or in the processes of a green larva which has become brown, or *vice versâ*. The blood of larvæ seems to be always acid (and so with all pupæ examined, except *E. punctaria*, of which the blood was neutral, in the only instance in which the blood of this pupa was tested), but I have as yet been unable to obtain a sufficient quantity of blood to determine what acid is present. The blood forms a solid, black coagulum which is due to oxidation, and does not take place when the blood is preserved in the manner described above. The injured parts of larvæ which have healed are black. It is probable that the darkening of pupæ and of the cuticular pigment of larvæ is also due to oxidation. There is great variability in the amount of clot formed and in the rapidity of the process.

Historical.—Mr. Raphael Meldola, in the *Proc. Zool. Soc.* for 1873, and in the editorial notes to his translation of Weismann's "Studies in the Theory of Descent," Part. II., "On the Origin of the Markings of Caterpillars," &c., argues very convincingly for the use of plant-pigments by green larvæ. He points out that internal feeders are never green unless their food contains chlorophyll, and that when this is the case (*Nepticula oxyacanthella*, &c.) they may be green, although the colour cannot be of any advantage to them. Pocklington (confirmed by Dr. MacMunn) found chlorophyll in the elytra of Cantharides, and Chautard seems doubtful about the same pigment in this situation (*Compt. Rend.*, January 13, 1873, and *Ann. Chim. Phys.*, 5, iii., 1–56). Dr. MacMunn found a band in the red which resembled chlorophyll, by concentrating light on the integument of the larva of *Pieris rapæ* and examining with a micro-spectroscope; but both he and Krukenberg refer the pigment to the larval digestive tract. (See *Reports* of British Association at Southport, 1883, and a letter by Dr. MacMunn to NATURE for the week ending January 10, 1885). It is very unlikely that the green colour of so thick and opaque a larva can be due to its digestive tract, and it is probable that the blood, with its dissolved metachlorophyll, was lost in the manipulation. From memory of the appearance of the larva, and from examining a blown specimen, I should certainly infer that there are also derived pigments in the subcuticular tissues.

The Relations between the Colour of Phytophagous Larvæ and that of their Food-Plants.—Entomologists have been long aware of the fact that the colours of many larvæ vary (within the limits of the same species) according to the colour of the plant upon which they are found. Complete references to the observations hitherto recorded upon this point occur in Mr. Meldola's writings (mentioned above). Among the most important of these is a paper by Mr. R. M'Lachlan (*Trans. Ent. Soc*, 1865, p. 453) in which data are given as to *Eupithecia absynthiata*, which were yellowish when found upon *Senecio jacobæa*, reddish upon *Centaurea nigra*, whitish upon Matricaria. When nearly full grown they were all given *Senecio jacobæa* without altering the colour of the reddish and whitish varieties. From this Mr. M'Lachlan argued (1) that it was necessary for the larvæ to have fed on the one kind of plant from the egg to acquire the resemblance; (2) that the colour is not caused by the food showing through the somewhat transparent integument. Mr. Meldola

quotes many instances in which the larva of *S. ligustri* has been observed to vary according to its food-plant (laurustinus, lilac, privet, ash). I have for many years known of the difference between the lilac and privet forms (the latter being of a brighter yellower green than the former, with brighter stripes). In 1884 I bred twelve larvæ from the egg upon privet, and the same number upon lilac. All the privet and six of the lilac larvæ reached maturity, and, without exception, showed the differences indicated above. A more remarkable instance is afforded by *Smerinthus ocellatus*. Mr. Meldola quotes Mr. E. Boscher as finding many yellowish-green varieties of this larva upon *Salix viminalis*, and many bluish-green varieties upon *S. triandra*, similar to those which are well known to occur upon apple. The former varieties possessed the rows of reddish-brown spots which sometimes occur on this variety of the larva. Upon another species of Salix he found instances of both varieties. In 1880 Mr. Boscher conducted some breeding experiments at Mr. Meldola's suggestion, feeding the larvæ from the egg upon *S. triandra*, *S. viminalis*, and apple, respectively. Only three of the third lot survived, and were all of the bluish-green form. I have also found (*Trans. Ent. Soc.*, Part I., April, 1884) that *S. rubra* and *S. cinerea* produce the yellowish variety, but *S. viminalis* the bluish form, according to my experience. In 1884 I fed five lots of six larvæ each, from the egg, upon apple, crab, *Salix viminalis*, *S. cinerea*, and *S. rubra*, respectively. On a few occasions *S. babylonica* and *triandra* were substituted for *S. rubra*, and ordinary apple for crab. The eggs were hatched July 15 to 18, and most of the larvæ were full fed by August 23, with the following results:—*Apple*: the five larvæ were typical bluish-green forms. *Crab*: the five larvæ were also typical bluish-green. *S. viminalis*: the four larvæ were not so whitish as the above-mentioned lots, but were almost intermediate. *S. cinerea*: the four larvæ were also intermediate. *S. rubra*: the four larvæ were yellower than any of the others, but were not much beyond intermediate forms. The yellowest was separated on August 14, and fed upon apple, becoming adult August 26, by which time it was rather whiter than any others of the same lot (*S. rubra*).

Thus there was no doubt about the effects produced, but there was a strong tendency all through towards the bluish variety, which the food-plant could only overcome to the extent of producing an intermediate form. The same conclusions were formed by a comparison of larvæ found in the field during 1884. Thus two nearly opposite varieties were found upon the same tree (? *S. ferruginea*, Anderson); an intermediate variety was found upon *S. rubra*, and a bright yellowish variety upon apple. At the same time the great majority of larvæ found were such as I should have anticipated.

Experiments were made upon the younger captured larvæ, which were fed upon food-plants tending towards a different colour. The results were similar to those indicated by the former experiments. Some effect could be produced in an intermediate variety by feeding it for some considerable time upon a food-plant known to have strong tendencies, but no such effect is produced upon a larva with a strongly-marked colour, *i.e.* one with strong tendencies itself, and corresponding with those of the food-plant. But the former experiments show that a very strong larval tendency may be counteracted to the extent of producing an intermediate form by feeding it from the egg upon a food-plant tending strongly in the other direction. When this latter effect has become manifest, it was proved that an appropriate change of the food at a comparatively late period may produce some considerable effect in the direction of the original tendency. The most probable explanation of the above-mentioned facts is that the effects of the food-plant are hereditary, and accumulate when the larvæ of successive generations feed upon plants with the same tendencies. Conversely feeding upon plants with different tendencies, and interbreeding, accounts for the irregularities observed. Thus in the larvæ fed from the egg, it is supposed that the previous generation (or generations) fed upon plants tending towards bluish-green larvæ. The yellowish larva found upon apple must have descended from a line fed upon *S. rubra*, or a plant with the same effects. The localisation of a food-plant would overcome both causes of irregularity, the liability to lay eggs on plants with different tendencies, and the chance of interbreeding between the two varieties.

This explanation is in accordance with the fact that the larvæ are of a very uniform tint upon apple trees in gardens, which are to a certain extent locally separated from the various species of sallow growing by the banks of streams, and in damp lanes and hedgerows. The strong effects produced upon the larvæ by apple, the usual proximity of many trees, and the sluggish flight of the Smerinthi, doubtless all conduce towards the uniformity between the larvæ upon this food-plant. On the other hand, there is the greatest facility for (the observed) irregularity in the results of sallow upon the larvæ, for many so-called species with various tendencies grow close together, so that there must be interbreeding and the deposition of eggs on various species of food-plants, even in the case of very sluggish insects. It is probable that certain conflicting statements as to the effect of the different food-plants upon the larva of *S. ligustri* are to be explained in the same way. As to the structural cause of the variability in these two larvæ, the main factor is a change in the relative amounts of the two derived pigments. Thus there is more xanthophyll in the blood of the pupa of a yellowish *S. ocellatus* than in the other case; and more chlorophyll with less xanthophyll, in the blood of the pupa of *S. ligustri*, from the greener larva fed upon lilac than from one fed upon privet. The result of this adjustment of the relative amounts of derived pigment is to produce a colour which harmonises with the part of the environment imitated—the undersides of the leaves in the case of *S. ocellatus*, the *tout ensemble* of the food-plant in the case of *S. ligustri*. In neither instance can the effects be due to the most direct and simple action of the food itself—the solution of its pigments in their normal proportion showing through the skin. This is disproved by the fact that *S. ocellatus eats* the whole leaf, but *resembles* the underside, and imitates in derived pigments an appearance largely due to texture; further, the effects do not at once follow a change of food, and a strong larval tendency may even cause the rearrangement of the derived pigments, so as to produce an effect *unlike* the leaf. The simple view allows no room for larval tendencies or for delayed effects. It has also been rendered very probable that the effects accumulate during successive generations. In the case of *S. ligustri* there is the additional difficulty that the larval pigment of the oblique stripes is affected by the food-plant as well as the derived pigments. Such effects cannot be explained by any simple theory of phytophagic effects, but it still holds good that phytophagic pigments play a most important part in larval coloration, and afford the chief material which is moulded by some influence—subtler than that which is implied by the term "phytophagic" itself—into likeness to a special part of the environment. The little we know of this influence points towards a nervous circle whose efferent effects are seen in the regulation of the passage of altered plant-pigments through the digestive tract into the blood, and finally the tissues, and in the colour of a certain amount of larval pigment, while the afferent part of the circuit must originate in some surface capable of responding to delicate shades of difference in the colour of the part of the environment imitated This interpretation is rendered unusually difficult by three facts: the gradual working of the process, often incomplete in a single life; the excessively complex and diverse results, and the special character of the stimulus (for it is only the part of the environment imitated which produces any effect —*e.g.* the *undersides* only of the leaves in the case of *S. ocellatus*). During the present year I hope to experiment further upon the subject, and I have a large number of living pupæ of *S. ocellatus*, with the life-histories of their respective larvæ carefully noted

Chemical Society, May 7.—Dr. Hugo Müller, F.R.S., President, in the chair.—The following papers were read:—On some points in the composition of soils; with results illustrating the sources of fertility of Manitoba prairie soils, by Sir J. B. Lawes, Bart., LL.D., F.R.S., F.C.S., and J. H. Gilbert, Ph.D., LL.D., F.R.S., V.P.C.S.—Researches on the relation between the molecular structure of carbon compounds and their absorption spectra, by Prof. W. N. Hartley, F.R.S. In continuation of the author's previous researches (*Trans.*, 1881, 57-60 and 111-128; 1883, 676-678), measurements have been made of the wave-lengths of the rays absorbed by the following substances:—(1) Aromatic hydrocarbons: benzene, the three xylenes, and naphthalene. (2) Aromatic tertiary bases and their salts: pyridine, picoline, quinoline, and their hydrochlorides. (3) Addition products of tertiary bases and salts: piperidine, tetrahydroquinoline, and its hydrochloride. (4) Primary aromatic bases or amido-derivatives and salts thereof: ortho- and para-toluidine and their hydrochlorides. In the preparation of solutions, a milligram-molecule, that is, the molecular weight

in milligrams, was dissolved in 20 c.c. of a diactinic solvent, and made up to a given volume, generally 20 c.c. In this way molecular weights were made to occupy equal volumes. Photographs of the absorption spectra were taken through definite thicknesses of solution. The lines of tin, lead, and cadmium were used as references; the positions of the bands were measured on the photographs by means of an ivory rule divided into hundredths of an inch, and those measurements were reduced by means of two curves to oscillation frequencies and wave-lengths. As far as possible, the absorption curves are drawn to a uniform scale. These curves indicate the *molecular actinic absorption* of each substance. The following deductions are drawn:—When an atom of nitrogen is substituted for an atom of carbon in the benzene or naphthalene nucleus, the property of selective absorption is still retained. When the condensation of the carbon and nitrogen in the molecule of a benzenoid compound or tertiary base is modified by the addition of an atom of hydrogen to each atom of carbon and nitroge , the power of selective absorption is destroyed. When the condensation of the carbon in quinoline is modified by the combination therewith of four atoms of hydrogen, the intensity of the selective absorption is reduced and is not destroyed. A very pure specimen of quinoline from coal-tar gave an absorption curve identical with that of quinoline prepared synthetically by Skraup's method. It may further be added that molecular actinic absorption of a salt is different from that of the organic base which it contains, although the acid exerts no absorptive power by itself. Sometimes the difference is very great, but the area included by the curve of the salt is always less than that of the base. Molecules vibrate as wholes or units, and the fundamental vibrations give rise to secondary vibrations which stand in no obvious relation to the chemical constituents of the molecule, whether these be atoms or smaller molecules. Hence it appears that a molecule is a distinct and individual particle which cannot be truly represented by our usual chemical formulæ, since these only symbolise certain chemical reactions and physical properties, and fail to express any relation between physical and chemical properties.—Researches on the action of the copper-zinc couple on organic bodies; Part x., benzyl bromide, by Dr. J. H. Gladstone, F.R.S., and Alfred Tribe.—On the selective alteration of the constituents of cast iron, by Thomas Turner, Assoc.R.S.M.—On the existence of nitrous anhydride in the gaseous state, by Prof. G. Lunge.—On the reaction between nitric oxide and oxygen under varying conditions, by Prof. G. Lunge. Experimental evidence is given for the following conclusions:—(1) That when nitric oxide is mixed in the dry state with an excess of oxygen they combine exclusively, or nearly so, to form N_2O_4. (2) Dry NO and O_2, with an excess of the former, yield a large proportion of N_2O_3 along with N_2O_4, both in the state of gas. (3) In the presence of water, NO in the presence of an excess of O_2 is altogether converted into HNO_3. (4) If NO and O_2 meet in the presence of concentrated sulphuric acid, neither N_2O_4 nor HNO_3 is formed, even with the greatest excess of oxygen; but the reaction is—

$$4SO_4H_2 + 4NO + O_2 = 4SO_2(OH)(ONO) + 2H_2O.$$

The bearing of these facts on the theory of the vitriol-chamber process is then discussed. The author considers that N_2O_3, and not NO as hitherto assumed, is the carrier of oxygen, and that as long as any appreciable quantity of SO_2 is present, no nitric oxide is formed, the following being the reactions whereby the sulphuric acid is formed:—

$$2SO_2 + N_2O_3 + O_2 + H_2O = 2SO_2(OH)(O_2N)$$
$$2SO_2(OH)(O_2N) + H_2O = 2SO_2(OH)_2 + N_2O_3.$$

Anthropological Institute, May 12.—Francis Galton, F.R.S., President, in the chair.—The election of R. Brudenell Carter, F.R.C.S., was announced.—The Earl of Northesk exhibited a collection of Maori worked jade.—Mr. Sepping Wright exhibited a portrait in oils of King Tawhiao, in native costume.—Mr. J. H. Kerry-Nicholls, F.R.G.S., read a paper on the origin and manners and customs of the Maori race. The origin of the Maoris and the date of their arrival in New Zealand is unknown. The natives refer to Hawaiki as the fatherland of their race, but there is no reliable evidence to show where that land was situated. The lecturer believed that the Maoris emigrated from the Tonga islands to New Zealand, and referred to the resemblance between the two races, and to the affinity of the two languages. The word *tonga* occurred no less than sixteen times in the Maori tongue. The natives of the two countries when they met could converse with but little difficulty. The Maoris are of Malay stock, and came with the gradual spread of that race through the eastern islands of the Pacific to the more southern groups. The race is greatly on the decrease. In Cook's time (1769) the whole native population was estimated to exceed 100,000. In 1859 it only amounted to 56,000. In 1881 the number had decreased to 44,099, of whom 24,370 were males and 19,729 females. Calculating at the same rate of decrease, about the year 2000 the Maori race would be extinct. The principal diseases conducing to this decay were phthisis, chronic asthma, and scrofula, the two first being principally brought about by a half savage, half civilised mode of life, and the latter from maladies contracted since the first contact with Europeans. The native religion still exercises a widespread influence over the people; it consists of a kind of polytheism, a worship of elementary spirits and deified ancestors. They have a vague conception of a Superior Being, and believe in a *Reinga*, or heaven, and a *Po*, or Hades. The Maoris are divided into tribes whose members are bound together by the strictest union. The ownership of the soil is by tribal tenure, and each tribe holds a commercial interest in lands, forests, cultivations, and fisheries. The tribes dwell together in villages, and each *hapu*, or tribal family, cultivates a portion of land sufficient to meet its immediate requirements. The Maoris own about 15,000,000 acres of land in the North Island, not yet alienated to Europeans. The ownership of the soil was secured to the natives under the treaty of Waitangi, made in 1840. The tribes are governed by hereditary chiefs. In 1858 a king was elected by consent of the tribes under the title of Potatau the First. He was succeeded by his son, Matutaera Te Pukepuke Te Paue Tu Karato Te-a-Botatau Te Wherowhero Tawhiao, or Potatau II. This was the king who last year visited this country.

EDINBURGH

Royal Society, May 18.—E. Sang, LL.D., Vice-President, in the chair.—The first instalment of a paper by Prof. Chrystal, on the Hessian, was read. The chief object was to contribute to the theory of the number of intersections of a curve and its Hessian at any one point as depending upon the nature of the singularity at that point.—In a paper on the distribution of potential in a thermo-electric circuit, open or closed, Prof. Tait detailed the various real additions to our knowledge of the subject in their chronological order. He showed what is at present the most probable arrangement of potential in the circuit, and what classes of experiments remain to be made in order to settle the point.—A paper by Mr. Broom gave numerical details of the percentage contraction of volume when a saturated solution of a salt in water is diluted with an equal bulk of pure water.

PARIS

Academy of Sciences, May 18.—M. Bouley, President, in the chair.—On the results of errors caused by defective instruments in the determination of certain astronomical elements, by M. M. Lœwy.—On the radiation of heat during the night in connection with the normal lowering of the temperature during the months of April and May, by M. J. Jamin. This lowering of the temperature, often so destructive to the spring crops, is rightly attributed by meteorologists to nocturnal radiation, which the author finds attains its maximum about the months of April and May.—Note on the prophylactic inoculation recently practised on Rio de Janeiro against yellow fever, by M. Bouley. This experiment, first introduced by Dr. Domingos Freire, has since been carried out on a large scale under the control of the Government. Since the month of March, 1883, as many as 1109 persons of all ages, nationalities and conditions of life have been subjected to sub-cutaneous injections with the attenuated virus cultivated for the purpose. In some cases the injections were administered in houses where the scourge had a few hours before proved fatal to some of the inmates. Yet no misadventure of any kind has followed, and this preventive measure seems so far to have been attended by the best results.—Anatomical study of the fœtus of a spermaceti whale, by M. Pouchet.—Note on the annular protuberance regarded as the prime motor of the cerebral mechanism, the focus or centre of localisation for speech, the reasoning faculty, and the will, by M. Bitot. From his studies in cerebrology the author concludes, against the generally accepted opinion, that the third left frontal convolution is not the seat or centre of speech, which he localises in the annular protuberance. In the same region he also considers that the

intelligence and will are localised, so that even slight lesions of the central part of the annular protuberance destroy both the faculty of speech and of reason. He accordingly denies that the strictly psychic faculties are located in the cerebral cortex, which is the seat only of the organs of sense.—Note on the influence of the ship's motions (rolling and pitching) on the observations made at sea with the Renouf mercury level, by M. O. Callandreau.—Remarks on the observations of the planet Saturn made during the present year with the 0·22 refractor of the Meudon Observatory, by M. E. L. Trouvelot.—Note on the verification of the laws of vibration for elastic circular plaques, by M. E. Mercadier.—On the production of induction sparks at high temperatures, and on its application to the study of the spectrum, by M. Eug. Demarçay.—Composition and heat of combustion of a variety of coal from the Altendorf mines of the Ruhr Basin, by M. Scheurer-Kestner.—Note on the buccal membrane characteristic of the cephalopods, by M. L. Vialleton. From a microscopic study of this organ, the use of which has hitherto been unknown, the author infers that it should probably be regarded as a rudimentary arm.—A study of the chlorophyll action of plants as distinct from their respiration, by MM. G. Bonnier and L. Mangin. By "chlorophyll action" the authors understand the decomposition of the carbonic acid of the atmosphere by the green parts of vegetables in the light. This function they claim to have separated from that of respiration hitherto studied in connection with it, and here give the first results of their researches on the two physiological functions studied apart. — Note on the uric acid present in the saliva and in the nasal, pharyngial, bronchial, and vaginal mucus, by M. Boucheron. — On the influence of the lunar declinations on the displacement of the atmospheric currents, by M. H. de Parville.—On the earthquakes and volcanic eruptions which are of such frequent occurrence in Central America, by M. de Montessus. The author here communicates some of the results of a systematic study of these phenomena prosecuted for the last four years at San Salvador and neighbouring districts.—Note on some underground rumblings heard in the Island of San Domingo on August 28, 1883—that is, on the same day as the Krakatoa eruption, by M. Alex. Llenas.—Remarks on M. Gavoy's work on the "Morphology of the Encephalon," presented to the Academy by M. Larrey.

BERLIN

Physical Society, March 8.—Dr. Kayser showed a new electro-dynamometer constructed according to the directions of Prof. Bellati. Hitherto dynamometers consisted of two spirals—an external one, fixed, and an internal, movable, with bifilar suspension, which, being both successively traversed by the currents to be measured, produced a deflexion of the movable spiral that was proportional to the square of the strength of the current. The technical difficulties attending the construction of these instruments were very great, and Prof. Bellati had therefore substituted for the inner spiral a bundle of annealed iron wires hanging to a cocoon thread inside the fixed spiral. Seeing the annealed iron wires possessed no residual magnetism, they were at once magnetised by any current and their deviation was likewise proportional to the square of the strength of the current. This dynamometer was highly sensitive with weak currents. An intercalated telephone, the membrane of which was feebly struck, gave deviations of from sixty to eighty parts of the scale—a sensitiveness which till then had been attained by no dynamometer. Dr. Kayser at the same time showed a globular dynamometer, after the design of Fröhlich, in which the inner spiral was coiled up like a ball, and a Siemens torsion dynamometer for strong currents in which the inner spiral was fixed, the outer movable, and the deviation read by a torsion apparatus. In the discussion which followed the speaker stated that the measurements hitherto taken had proved great precision on the part of Prof. Bellati's dynamometer.—Dr. Dieterici reported on the results of an investigation carried out by him in the last session into the electric residuum. The phenomenon had been experimentally examined by Prof. Kohlrausch, and theoretically treated by Riemann; but the formulæ set up by the latter did not correspond with the results of the experiments, and therefore the speaker undertook a new treatment of the subject. The experiments were carried out with a condenser, the lower plate of which was connected with the earth, the upper with a small mercury cup. A metal hoop led from the latter to a second mercury cup which on one side communicated through a metallic wire with one half of a quadrant electrometer, and on the other side through a second hoop with a third mercury cup. The second half of the electrometer and the third mercury cup were in permanent communication with the earth. The two hoops could alternately be raised out of the quicksilver by cords passing over a pulley or let down. If the first hoop were lifted up, the electrometer was conducted to the earth, the upper condenser plate, on the other hand, was isolated, and could now be charged. Thereupon the hoop was let down; the condenser now stood in connection with the earth and discharged itself. Finally, if the second hoop were raised, the condenser was connected with the electrometer, and both isolated. The residuum after the discharge could now be measured. The charge was effected by the highly constant dry Daniell cells (according to Herr v. Beetz), and in the different series of experiments the continuance of the charge was varied between five minutes and twenty-four hours, as the strength of the current was likewise varied. For each duration and strength of charge the residuum was determined in its course in respect of time in a series of individual determinations. The dielectric of the condenser was a paraffin plate and air. The experiments showed that under a charge of short duration—say, five to ten minutes—the residuum rose very rapidly with the time, and soon attained its maximum; so that its curve mounted very steeply and soon ran parallel to the abscissa of the time. Under a charge of long duration, again, the curve rose more slowly indeed; had, however, always greater values, and lay with more flat bend over the curve of short charge. On changing the strength of the current the electric residuum was always in proportion. Dr. Dieterici now treated the theory of the phenomenon, and briefly sketched the course of its theoretic investigation, which, under the assumption that the dielectric was infinitely thick—that is, neglecting the influence of the thickness—led to formulæ which very well explained the experimental results. The formulæ were, however, only empirical: they did not allow the determination of the constants of the phenomenon. In conclusion, the speaker dwelt on the analogy of the electric residuum to the phenomena of heat, which had also under theoretic treatment found its expression by application of heat-formulæ, and to the elastic after-effect which Prof. Kohlrausch had already pointed out.

ROME

Reale Accademia dei Lincei, March 1.—Fossil remains of *Dioplodon* and *Mesoplodon*, found in the Upper Tertiary in Italy.—Signor Capellini made a communication concerning a paper of his, in which he illustrates and describes the fossil remains of Ziphioids with elongated belemnite-shaped beak, found in various places in Italy. These remains belong to the following species:—*Dioplodon longirostris*, *D. gibbus*, *D. tenuirostris*, *D. bononiensis*, *D. medilineatus*, *D. senensis*, *D. laveleyi*, *D. meneghinii*. A few remains are ascribable to the genus *Mesoplodon*. The specimen described by the author add seven species of Ziphioids to the fossil cetaceans found in Italy; four of these being already known in the Upper Tertiary of Belgium and England, while the three others are entirely new. It must be remembered that before 1875 no fossil remains of Ziphioids were known to exist in Italy. From that time till now there have been discovered about ten species, some of the remains belonging to which are of great importance to palæontology and stratigraphical geology.—On the mineral volcanic *ejectamenta* found in the east of the Lake of Bracciano.—Signor Strüver communicated an abstract of a memoir, in which he explains how, after long and fruitless searches, there had been found within the last few years, in the region lying to the east of the Lake of Bracciano, numerous mineral *ejectamenta* similar to the bombs of Monte Somma, and the mineral aggregates of the Monti Albani, of Pitigliano, and of Lake Laach, in Germany. These *ejectamenta* are found between strata of tuff or *lapilli* and fragments of various rocks. Among the numerous minerals composing the aggregates, Prof. Strüver draws special attention to the sarcolite, a mineral hitherto found but rarely, and that only on Monte Somma. The *ejectamenta* in question present, in respect of the extraordinary diversity in their forms, great analogy to the aggregates of a like nature found in the other places mentioned, but nevertheless have a local stamp of their own, and their diversity is in correspondence with the position of the volcanoes from which they were ejected, and the rocks of the regions in which these volcanoes were active. Prof. Strüver draws attention to the fact that these aggregates must at one

time have been united together and formed a single deposit, and shows how that excludes the hypotheses that they were formed in the place where they are now found, and that they are derived from deposits anterior to the period of volcanic activity. —On the relations between the maxima and minima of the solar protuberances, and the maxima and minima of the diurnal oscillation of the declination magnet. Prof. Tacchini, after giving an account of his own researches already published, on the maxima and minima of the sunspots and solar protuberances, referred to the observations of Prof. Schiapparelli on the values of the range of diurnal oscillation of the declination needle, and from the comparison of the two sets of observations, it appears that of late years the connection between the solar protuberances and terrestrial magnetism is more strikingly manifest. These and other similar observations, Prof. Tacchini added, corroborate the idea entertained by himself and some others, that electricity plays the chief part in the solar protuberances, and that electricity is able to produce corresponding magnetic disturbances on our globe. It may therefore be inferred with certainty that the phenomena of the sunspots, the solar protuberances, and terrestrial magnetism are closely connected together, and that by means of one of these sets of phenomena it is possible to determine with tolerable precision the epoch of the other two. In dealing, however, with phenomena of rather long period continuous observations for at least half a century are necessary to make our researches complete.—On the spectroscopic observations of the limb of the sun and the solar protuberances made in 1881 and 1884 at the Royal Observatory of the Capitol.—Prof. Respighi laid before the meeting some considerations of his own, based on observations made in his own observatory, and leading him to conclusions different from those of Prof. Tacchini. He maintains that the maximum of solar protuberances occurred towards the end of the third quarter of 1881. Holding that the sun-spots are due to partial cooling of the surface of the sun, and the protuberances to the escape of gases from the interior, Prof. Respighi believes that such perturbations are not of a nature to occur in periods, even though they retain a certain relation among themselves, and still less can he admit any connection between the maxima of the solar protuberances and the elements of terrestrial magnetism.—Meteorological observations made by Signor P. Orlandi, a physician of Rome, during the years 1809–1820. Signor Narducci called attention to a manuscript in the Biblioteca Angelica, containing some interesting medico-meteorological observations made by Signor Orlandi, a medical man belonging to Rome, between the years 1809 and 1820. These observations are copious and complete, having been made daily. They also include notices of movements of the earth's crust and inundations of the Tiber. Signor Narducci mentioned that Dr. Orlandi was a man of science and writer of great renown in his time. Large extracts from the observations of Orlandi are to be published in the *Annals* of the Central Office of Meteorology, and they will thus be able to be compared with those published by distinguished astronomers belonging to the same epoch.—On the last and recent maximum of sun-spots and solar protuberances. Prof. Riccò gave an account of his own observations made at Palermo on the phenomenon of the solar protuberances, which was so important on account of its coincidence in time with very singular manifestations of the solar maculæ. Prof. Riccò deduced from his own observations, harmonising, as they do, with those of Prof. Tacchini, that, starting from the last maximum in the period of eleven years, the number of the protuberances went on increasing till 1881, when a first maximum occurred. It was further verified that the absolute maximum fell between the end of 1803 and the beginning of 1804, and that on that occasion the maximum of protuberances continued beyond that of the sun-spots. Finally, leaving out of account secondary oscillations, Prof. Riccò asserted that a parallelism may be observed between the frequency of sun-spots and protuberances, the principal maxima and minima of both phenomena coinciding with one another.—On the relation between the maxima and minima of the sun-spots and the maxima and minima of the diurnal variations of the declination needle observed at Genoa. Prof. Garibaldi has made a comparison between the normal compensated series of groups of sun-spots observed by Prof. Tacchini during the period 1877–84 and the series of diurnal variations of the declination needle observed at Genoa during the same period. From the mirror-tracings of the author it appears that the two series agree perfectly. Hence, considering that the observation of the sun and its spots depends upon the clearness of the sky, while the magnetic influence of the sun can always act, and observations of magnetic changes can always be easily made, Prof. Garibaldi arrives at the conclusion that the epochs of maxima and minima of the sun-spots may be inferred from the indications of the declination needle when direct observations are not obtainable.—Action of nascent hydrogen on methyl-pyrrol. Drs. Ciamician and Magnaghi having already ascertained by previous researches that *pyrrol* is converted into an alkaloid called *pyrrolin* under the action of nascent hydrogen, communicated a preliminary notice of the experiments commenced by them with the view of increasing the number of bodies belonging to the pyrrolin series, experiments in which they studied the action of nascent hydrogen on other derivatives of pyrrol.—On a method for the electric calibration of a metallic wire. Dr. Ascoli, pointing out that in accurate measurements it cannot be assumed that the length and resistance of a wire stand in a constant relation to one another, described a very simple and easily applied method of his own by means of which a wire can be quickly and perfectly calibrated without the aid of special instruments and without accessory measurements. By the construction of a curve the resistance of the corresponding piece of wire is obtained from the area limited by the curve.—Other communications: Prof. Besso presented a first note on a class of differential linear equations of the fourth order and on the equation of the fifth degree.—Prof. Gomes-Teixeira furnished a paper on the determination of the algebraic part of the integral of rational functions.—Prof. Riccò made a preliminary note on the observations made by him on red glows.—Dr. de Franchis offered various considerations on some relations between the velocities of efflux, the specific heats, and the mean squares of the molecular velocities of gases.

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